Article 34 Amendment

[Translation]

AMENDMENT

(Amendment based on PCT article 34)

4. Object of Amendment Specification and Claims

5. Contents of Amendment

(1) The description "The invention recited in claim 1 is ... the tire equatorial plane." in the Japanese specification, on page 2, lines 13 to 18 (corresponding to the English translation thereof on page 3, paragraph 0007) is amended as follows. Consequently, page 2 of the Japanese specification is substituted with a substitute page 2.

" The invention recited in claim 1 is a pneumatic tire comprising: a land portion disposed on an equatorial plane of a tread, the land portion extending continuously in a tire circumferential direction; steep-angle grooves provided at opposite sides of the tire equatorial plane of the tread, the steep-angle grooves being inclined at an angle of not more than 45 degrees relative to the tire circumferential direction such that the steep-angle grooves contact the ground from a side thereof near the tire equatorial plane, an end portion of each steep-angle groove near the tire equatorial plane terminating within the land portion; and recessed portions formed in the land portion along adjacent tread surface side edges at a tire axial direction inner side of the steep-angle grooves, a depth of the recessed portions gradually increasing and a width of the recessed portions gradually decreasing from longitudinal directional middle portions of the steep-angle grooves toward end portions of the steep-angle grooves near the tire equatorial plane."

(2) The description "In the pneumatic tire recited in claim 1, ... can be smoothly drained." in the Japanese specification on page 2, lines 20 to 27 (corresponding to the English translation thereof on page 3, paragraph 0009) is amended as follows. Consequently, page 2 of the Japanese specification is substituted with a substitute page 2.

"In the pneumatic tire recited in claim 1, the steep-angle grooves are provided at the opposite sides of the tire equatorial plane of the tread. The steep-angle grooves are inclined at an angle of not more than 45 degrees relative to the tire circumferential direction such that the steep-angle grooves contact the ground from the side thereof near the tire equatorial plane. This tread pattern is a so-called directional pattern, and therefore, water in a contact patch area can be smoothly drained.

Further, the recessed portions, which have a depth gradually increasing and a width gradually decreasing from the longitudinal directional middle portions of the steep-angle grooves toward the end portions of the steep-angle grooves near the tire equatorial plane, are formed in the land portion along adjacent tread surface side edges at the tire axial direction inner side of the steep-angle grooves. Therefore, water around the center of the contact patch area can be smoothly drained from the tread surface into the steep-angle grooves through the recessed portions."

(3) The description "The invention recited in claim 3 is ... in the tire axial direction." in the Japanese specification on page 3, lines 16 to 20 (corresponding to the English translation thereof on page 5, paragraph 00016) is amended as follows. Consequently, page 3 of the Japanese specification is substituted with a substitute page 3.

"The invention recited in claim 3 is the pneumatic tire recited in claim 1or 2,

wherein the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at another side of the tire equatorial plane are aligned in a straight line in the circumferential direction."

(4) The description "Accordingly, it is preferred ... in the tire axial direction. " in the Japanese specification on page 3, lines 26 to 28 (corresponding to the English translation thereof on pages 5-6, paragraph 00019) is amended as follows. Consequently, page 3 of the Japanese specification is substituted with a substitute page 3.

"Accordingly, it is preferred that the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines at one side of the tire equatorial plane and the boundary lines at the other side of the tire equatorial plane are aligned in a straight line in the circumferential direction.

The invention recited in claim 4 is the pneumatic tire recited in claim 1 or 2, wherein the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at another side of the tire equatorial plane are spaced apart from each other outward in the tire axial direction.

Next, effect of the pneumatic tire recited in claim 4 is described.

If the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at the other side of the tire

equatorial plane are not spaced apart outward in the tire axial direction, the recessed portions at one side of the tire equatorial plane and the recessed portions at the other side of the tire equatorial plane are alternately aligned on the same circumferential line. This lowers rigidity of the land portion in the vicinity of the tire equatorial plane, leading to lower control stability, and therefore is not preferred. Accordingly, it is preferred that the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines at one side of the tire equatorial plane and the boundary lines at the other side of the tire equatorial plane are spaced apart from each other outward in the tire axial direction."

(5) The description "The invention recited in claim 4 is ... in the tire circumferential direction." in the Japanese specification on page 4, lines 1 to 4 (corresponding to the English translation thereof on pages 6-7, paragraph 0020) is amended as follows. Consequently, page 4 of the Japanese specification is substituted with a substitute page 4.

"The invention recited in claim 5 is the pneumatic tire recited in any one of claims 1 to 4, wherein the recessed portions are formed to extend from longitudinal directional middle portions of the steep-angle grooves to end portions of the steep-angle grooves near the tire equatorial plane, and a length of the recessed portions measured along the tire circumferential direction is set within a range from 25 to 50 % of an arrangement pitch of the steep-angle grooves in the tire circumferential direction."

(6) The description "Next, effect of the pneumatic tire recited in claim 4 is described." in the Japanese specification on page 4, line 5 (corresponding to the English translation thereof on page 7, paragraph 0021) is amended as follows. Consequently, page 4 of

the Japanese specification is substituted with a substitute page 4.

"Next, effect of the pneumatic tire recited in claim 5 is described."

(7) The description "The invention recited in claim 5 is ... of the steep-angle groove." in the Japanese specification on page 4, lines 18 to 21 (corresponding to the English translation thereof on page 8, paragraph 0026) is amended as follows. Consequently, page 4 of the Japanese specification is substituted with a substitute page 4.

"The invention recited in claim 6 is the pneumatic tire recited in any one of claims 1 to 5, wherein a height of the deepest portion of each recessed portion measured from a groove bottom of the adjacent steep-angle groove to the tire radial direction outer side is set within a range from 25 to 75 % of a groove depth of the steep-angle grooves."

(8) The description "Next, effect of the pneumatic tire recited in claim 5 is described." in the Japanese specification on page 4, line 22 (corresponding to the English translation thereof on page 8, paragraph 0027) is amended as follows. Consequently, page 4 of the Japanese specification is substituted with a substitute page 4.

"Next, effect of the pneumatic tire recited in claim 6 is described."

(9) The description "the steep-angle grooves ... water drainage ability can be obtained." in the Japanese specification on page 5, lines 4 to 6 (corresponding to the English translation thereof on page 9, paragraph 0031) is amended as follows. Consequently, page 5 of the Japanese specification is substituted with substitute pages 4 and 5.

"The invention recited in claim 7 is the pneumatic tire recited in any one of claims 1 to 6, wherein the steep-angle grooves are arranged with a phase difference in the circumferential direction between those at one side of the tire equatorial plane and those at the other side of the tire equatorial plane."

(10) The description "Next, effect of the pneumatic tire recited in claim 6 is described." in the Japanese specification on page 5, line 7 (corresponding to the English translation thereof on page 9, paragraph 0032) is amended as follows. Consequently, page 5 of the Japanese specification is substituted with a substitute page 5.

"Next, effect of the pneumatic tire recited in claim 7 is described."

(11) The description "The invention recited in claim 7 is ... within a range from 5 to 30 degrees." in the Japanese specification, on page 5, lines 11 to 13 (corresponding to the English translation thereof on page 9, paragraph 0034) is amended as follows. Consequently, page 5 of the Japanese specification is substituted with a substitute page 5.

"The invention recited in claim 8 is the pneumatic tire recited in any one of claims 1 to 7, wherein an angle of the steep-angle grooves relative to the tire circumferential direction is set within a range from 5 to 30 degrees."

(12) The description "Next, effect of the pneumatic tire recited in claim 7 is described." in the Japanese specification on page 5, line 14 (corresponding to the English translation thereof on page 9, paragraph 0035) is amended as follows. Consequently, page 5 of the Japanese specification is substituted with a substitute page 5.

"Next, effect of the pneumatic tire recited in claim 8 is described."

(13) The description "The invention recited in claim 8 is ... tread contact-area ends." in the Japanese specification on page 5, lines 17 to 19 (corresponding to the English translation thereof on page 9, paragraph 0037) is amended as follows. Consequently, page 5 of the Japanese specification is substituted with a substitute page 5.

"The invention recited in claim 9 is the pneumatic tire recited in any one of claims 1 to 8, further comprising transverse grooves provided at the axial

direction outer sides from the steep-angle grooves, the transverse grooves opening toward respective tread contact-area ends."

(14) The description "Next, effect of the pneumatic tire recited in claim 8 is described." in the Japanese specification on page 5, line 20 (corresponding to the English translation thereof on page 9, paragraph 0038) is amended as follows. Consequently, page 5 of the Japanese specification is substituted with a substitute page 5.

"Next, effect of the pneumatic tire recited in claim 9 is described."

(15) The description "The invention recited in claim 9 is ... tread contact-area ends." in the Japanese specification, on page 5, lines 25 to 28 (corresponding to the English translation thereof on page 10, paragraph 0040) is amended as follows. Consequently, page 5 of the Japanese specification is substituted with a substitute page 5.

"The invention recited in claim 10 is the pneumatic tire recited in any one of claims 1 to 9, further comprising circumferential grooves extending in the tire circumferential direction, the circumferential grooves being disposed in areas of 40 to 60 % of a tread half width from the tire equatorial plane toward the respective tread contact-area ends."

(16) The description "Next, effect of the pneumatic tire recited in claim 9 is described." in the Japanese specification on page 6, line 1 (corresponding to the English translation thereof on page 10, paragraph 0041) is amended as follows. Consequently, page 6 of the Japanese specification is substituted with a substitute page 5.

"Next, effect of the pneumatic tire recited in claim 10 is described."

(17) The description "It should be noted that, in the pneumatic tire recited in claim 9, circumferential grooves is small (two)." in the Japanese specification on page 6, lines 9 to 11 (corresponding to the English translation thereof on page 11, paragraph 0045) is

amended as follows. Consequently, page 6 of the Japanese specification is substituted with substitute pages 5 and 6.

"It should be noted that, in the pneumatic tire recited in claim 10, although the tread includes the circumferential grooves, lowering of the rain groove wandering resistance is of a degree that does not matter practically, since the number of the circumferential grooves is small (two).

The invention recited in claim 11 is the pneumatic tire recited in any one of claims 1 to 10, wherein the recessed portions at the right and left sides of the tire equatorial plane are arranged not to overlap with each other in the tire width direction.

Next, effect of the pneumatic tire recited in claim 11 is described.

By arranging the recessed portions at the right and left sides of the tire equatorial plane not to overlap with each other in the tire width direction, no area is produced where the recessed portions at one side of the tire equatorial plane and those at the other side of the tire equatorial plane are positioned side by side in the axial direction, so that no insufficiency of contact patch area is brought about."

(18) The description "The pneumatic tire recited in claim 3 ... can be obtained." in the Japanese specification on page 6, lines 19 to 20 (corresponding to the English translation thereof on page 12, paragraph 0048) is amended as follows. Consequently, page 6 of the Japanese specification is substituted with a substitute page 6.

"The pneumatic tire recited in claim 3 having the above described structure has an excellent effect that high control stability can be obtained. The pneumatic tire recited in claim 4 having the above described structure has an excellent effect that high control stability can be obtained."

(19) The description "The pneumatic tire recited in claim 4 ... can be obtained." in the Japanese specification on page 6, lines 21 to 23 (corresponding to the English translation thereof on page 12, paragraph 0049) is amended as follows. Consequently, page 6 of the Japanese specification is substituted with a substitute page 6.

"The pneumatic tire recited in claim 5 having the above described structure has an excellent effect that water in the vicinity of the tire equatorial plane in the contact patch area can be efficiently drained, and therefore high wet road performance can be obtained."

(20) The description "The pneumatic tire recited in claim 5 ... of the land portions." in the Japanese specification on page 6, lines 24 to 25 (corresponding to the English translation thereof on page 12, paragraph 0050) is amended as follows. Consequently, page 6 of the Japanese specification is substituted with a substitute page 6.

"The pneumatic tire recited in claim 6 having the above described structure has an excellent effect that high wet road performance can be obtained while ensuring rigidity of the land portions."

(21) The description "The pneumatic tire recited in claim 6 ... can be obtained." in the Japanese specification on page 6, lines 26 to 28 (corresponding to the English translation thereof on page 12, paragraph 0051) is amended as follows. Consequently, page 6 of the Japanese specification is substituted with a substitute page 6.

"The pneumatic tire recited in claim 7 having the above described structure has excellent effects that pattern noise can be suppressed, and uniform land portion rigidity along the circumference and water drainage ability can be obtained."

(22) The description "The pneumatic tire recited in claim 6 ... can be obtained." in the Japanese specification on page 7, lines 26 to 28 (corresponding to the English translation thereof on page 12, paragraph 0052) is amended as follows. Consequently,

page 7 of the Japanese specification is substituted with a substitute page 6.

"The pneumatic tire recited in claim 8 having the above described structure has an excellent effect that high water drainage ability on a wet road can be obtained."

(23) The description "The pneumatic tire recited in claim 8 ... can be obtained." in the Japanese specification on page 7, lines 3 to 5 (corresponding to the English translation thereof on page 12, paragraph 0053) is amended as follows. Consequently, page 7 of the Japanese specification is substituted with a substitute page 6.

"The pneumatic tire recited in claim 9 having the above described structure has an excellent effect that water led into the steep-angle grooves can be efficiently drained to the tire axial direction outer sides of the ground contacting area through the transverse grooves, and therefore, high wet performance can be obtained."

(24) The description "Moreover, the pneumatic tire recited in claim 9 ... rain groove wandering." in the Japanese specification on page 7, lines 6 to 8 (corresponding to the English translation thereof on page 12/1, paragraph 0054) is amended as follows. Consequently, page 7 of the Japanese specification is substituted with a substitute page 7.

"The pneumatic tire recited in claim 10 having the above described structure has an excellent effect that water drainage ability on a wet road can further be improved with avoiding rain groove wandering. Moreover, the pneumatic tire recited in claim 11 having the above described structure has an excellent effect that no insufficiency of ground contacting area is achieved."

(25) Claims 1 and 3-9 in the Claims are amended as shown in attached sheets, and claims 10 and 11 are added.

6. List of Enclosures

(1) Pages 2 to 7 of the Japanese specification (corresponding to pages 2 to 12/3 of the English translation thereof)

(2) Pages 16 and 17 of the Japanese claims (corresponding to pages 26 to 28/1 of the English translation thereof)

Patent Document 5: JP-A No. 8-85309

Patent Document 6: JP-A No. 5-286312

Patent Document 7: JP-A No. 10-287108

Patent Document 8: JP-A No. 4-78604

Patent Document 9: JP-A No. 4-43105

Disclosure of Invention

Problems to be Solved by the Invention

[0003] Some highways, for example, in North America employ so-called rain groove roads where many grooves are formed in the road surface in order to promote water drainage.

[0004] Water drainage of a tire is improved by forming in the tread a groove extending in the circumferential direction of the tire, however, if a tire pattern includes plural grooves extending in the circumferential direction, the tire pattern may cause so-called rain groove wandering, where steering controllability is lowered on a rain groove road, depending on a combination of a groove width and an interval between grooves.

[0005] However, merely reducing the number of circumferential directional grooves for suppressing rain groove wandering will lead to another problem of lowering in wet road performance of the tire.

[0006] The present invention is made to solve the above described problems, and is directed to provide a pneumatic tire with which rain groove wandering resistance is readily achieved without sacrificing wet road performance and other performances.

Means for Solving the Problems

[0007] The invention recited in claim 1 is a pneumatic tire comprising: a land portion disposed on an equatorial plane of a tread, the land portion extending continuously in a tire circumferential direction; steep-angle grooves provided at opposite sides of the tire equatorial plane of the tread, the steep-angle grooves being inclined at an angle of not more than 45 degrees relative to the tire circumferential direction such that the steep-angle grooves contact the ground from a side thereof near the tire equatorial plane, an end portion of each steep-angle groove near the tire equatorial plane terminating within the land portion; and recessed portions formed in the land portion along adjacent tread surface side edges at a tire axial direction inner side of the steep-angle grooves, a depth of the recessed portions gradually increasing and a width of the recessed portions gradually decreasing from longitudinal directional middle portions of the steep-angle grooves toward end portions of the steep-angle grooves near the tire equatorial plane.

[0008] Next, effect of the pneumatic tire recited in claim 1 is described.

[0009] In the pneumatic tire recited in claim 1, the steep-angle grooves are provided at the opposite sides of the tire equatorial plane of the tread. The steep-angle grooves are inclined at an angle of not more than 45 degrees relative to the tire circumferential direction such that the steep-angle grooves contact the ground from the side thereof near the tire equatorial plane. This tread pattern is a so-called directional pattern, and therefore, water in a contact patch area can be smoothly drained.

Further, the recessed portions, which have a depth gradually increasing and a width gradually decreasing from the longitudinal directional middle

portions of the steep-angle grooves toward the end portions of the steep-angle grooves near the tire equatorial plane, are formed in the land portion along adjacent tread surface side edges at the tire axial direction inner side of the steep-angle grooves. Therefore, water around the center of the contact patch area can be smoothly drained from the tread surface into the steep-angle grooves through the recessed portions.

[00010]Accordingly, even if no circumferential groove is provided, or only a small number of circumferential grooves are provided, high wet road performance can be obtained.

[00011]In addition, since the number of the circumferential groove can be reduced or the circumferential groove can be eliminated, occurrence of rain groove wandering can be suppressed.

[00012] It should be noted that, since the depth of the recessed portions gradually increases and the width thereof gradually decreases from the longitudinal directional middle portions of the steep-angle grooves toward the end portions of the steep-angle grooves near the tire equatorial plane, rigidity of the land portion in the vicinity of the recessed portions is ensured.

[00013]The invention recited in claim 2 is the pneumatic tire recited in claim 1, wherein an angle, relative to the tire circumferential direction, of boundary lines between the recessed portions and a tread surface of the land portion near the tire equatorial plane is set to not more than 15 degrees when viewed in a plan view of the tread, and an angle of land side wall surfaces of the recessed portions relative to lines normal to the tread surface of the tread is set to not more than 30 degrees when viewed in cross section along a tire radial direction that is orthogonal to the longitudinal direction of the steep-angle grooves.

[00014]Next, effect of the pneumatic tire recited in claim 2 is described.

[00015]By setting the angle relative to the tire circumferential direction of boundary lines to not more than 15 degrees and the angle of land side wall surfaces of the recessed portions to not more than 30 degrees, the recessed portions can work to efficiently drain water from the tread surface into the steep-angle grooves.

[00016]The invention recited in claim 3 is the pneumatic tire recited in claim 1or 2, wherein the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at another side of the tire equatorial plane are aligned in a straight line in the circumferential direction.

[00017]Next, effect of the pneumatic tire recited in claim 3 is described.

[00018]If the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at the other side of the tire equatorial plane are not spaced apart outward in the tire axial direction, the recessed portions at one side of the tire equatorial plane and the recessed portions at the other side of the tire equatorial plane are alternately aligned on the same circumferential line. This lowers rigidity of the land portion in the vicinity of the tire equatorial plane, leading to lower control stability, and therefore is not preferred.

[00019]Accordingly, it is preferred that the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines at one side of the tire

equatorial plane and the boundary lines at the other side of the tire equatorial plane are aligned in a straight line in the circumferential direction.

The invention recited in claim 4 is the pneumatic tire recited in claim 1 or 2, wherein the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at another side of the tire equatorial plane are spaced apart from each other outward in the tire axial direction.

Next, effect of the pneumatic tire recited in claim 4 is described.

If the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at the other side of the tire equatorial plane are not spaced apart outward in the tire axial direction, the recessed portions at one side of the tire equatorial plane and the recessed portions at the other side of the tire equatorial plane are alternately aligned on the same circumferential line. This lowers rigidity of the land portion in the vicinity of the tire equatorial plane, leading to lower control stability, and therefore is not preferred. Accordingly, it is preferred that the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines at one side of the tire equatorial plane and the boundary lines at the other side of the tire equatorial plane are spaced apart from each other outward in the tire axial direction.

[0020] The invention recited in claim 5 is the pneumatic tire recited in any one of claims 1 to 4, wherein the recessed portions are formed to extend from

longitudinal directional middle portions of the steep-angle grooves to end portions of the steep-angle grooves near the tire equatorial plane, and a length of the recessed portions measured along the tire circumferential direction is set within a range from 25 to 50 % of an arrangement pitch of the steep-angle grooves in the tire circumferential direction.

[0021] Next, effect of the pneumatic tire recited in claim 5 is described.

[0022] In order to efficiently drain water in the vicinity of the tire equatorial plane in the contact patch area, it is preferred that the recessed portions are formed to extend from the longitudinal directional middle portions of the steep-angle grooves to the end portions of the steep-angle grooves near the tire equatorial plane.

[0023] Here, if the length of the recessed portions measured along the tire circumferential direction is less than 25 % of the arrangement pitch of the steep-angle grooves in the tire circumferential direction, the length of the recessed portions is too short to efficiently drain water into the steep-angle grooves.

[0024] On the other hand, if the length of the recessed portions measured along the tire circumferential direction exceeds 50 % of the arrangement pitch of the steep-angle grooves in the tire circumferential direction, areas are produced where the recessed portions provided at one side of the tire equatorial plane and the recessed portions provided at the other side of the tire equatorial plane are positioned side by side in the axial direction. At such areas, both of right and left portions of the tire equatorial plane on the circumference of the tire do not contact the ground, resulting in insufficient contact patch area.

[0025] Accordingly, it is preferred that the recessed portions are formed to extend from the longitudinal directional middle portions of the steep-angle grooves to the end portions of the steep-angle grooves near the tire equatorial plane, and the length of the recessed portions measured along the tire circumferential direction is set within a range from 25 to 50 % of the arrangement pitch of the steep-angle grooves in the tire circumferential direction.

[0026] The invention recited in claim 6 is the pneumatic tire recited in any one of claims 1 to 5, wherein a height of the deepest portion of each recessed portion measured from a groove bottom of the adjacent steep-angle groove to the tire radial direction outer side is set within a range from 25 to 75 % of a groove depth of the steep-angle grooves.

[0027] Next, effect of the pneumatic tire recited in claim 6 is described.

[0028] If the height of the deepest portions of the recessed portions measured from the groove bottom of the adjacent steep-angle grooves to the tire radial direction outer side is less than 25 % of the groove depth of the steep-angle transverse grooves, rigidity of the land portions around the recessed portions excessively decreases, and this is not preferred.

[0029] On the other hand, if the height of the deepest portions of the recessed portions measured from the groove bottom of the adjacent steep-angle grooves to the tire radial direction outer side exceeds 75 % of the groove depth of the steep-angle transverse grooves, efficient drainage of water into the steep-angle grooves is hindered.

[0030] Accordingly, it is preferred that the height of the deepest portions of the recessed portions measured from the groove bottom of the adjacent steep-angle

grooves to the tire radial direction outer side is set within a range from 25 to 75 % of the groove depth of the steep-angle grooves.

[0031] The invention recited in claim 7 is the pneumatic tire recited in any one of claims 1 to 6, wherein the steep-angle grooves are arranged with a phase difference in the circumferential direction between those at one side of the tire equatorial plane and those at the other side of the tire equatorial plane.

[0032] Next, effect of the pneumatic tire recited in claim7 is described.

[0033] By arranging the steep-angle grooves with a phase difference in the circumferential direction between those at one side of the tire equatorial plane and those at the other side of the tire equatorial plane, pattern noise can be suppressed, and land portion rigidity uniform along the circumference and water drainage ability can be obtained.

[0034] The invention recited in claim 8 is the pneumatic tire recited in any one of claims 1 to 7, wherein an angle of the steep-angle grooves relative to the tire circumferential direction is set within a range from 5 to 30 degrees.

[0035] Next, effect of the pneumatic tire recited in claim 8 is described.

[0036] By setting the angle of the steep-angle grooves relative to the tire circumferential direction within the range from 5 to 30 degrees, high water drainage ability of the tire on a wet road can be obtained.

[0037] The invention recited in claim 9 is the pneumatic tire recited in any one of claims 1 to 8, further comprising transverse grooves provided at the axial direction outer sides from the steep-angle grooves, the transverse grooves opening toward respective tread contact-area ends.

[0038] Next, effect of the pneumatic tire recited in claim 9 is described.

[0039] By providing the transverse grooves, which open toward respective tread contact-area ends, at the tire axial direction outer sides from the steep-angle grooves, water led into the steep-angle grooves can be efficiently drained through the transverse grooves to the tire axial direction outer sides of the contact area. It should be noted that the steep-angle groove may be directly connected to the transverse grooves, or may be connected via other grooves such as circumferential grooves.

[0040] The invention recited in claim 10 is the pneumatic tire recited in any one of claims 1 to 9, further comprising circumferential grooves extending in the tire circumferential direction, the circumferential grooves being disposed in areas of 40 to 60 % of a tread half width from the tire equatorial plane toward the respective tread contact-area ends.

[0041] Next, effect of the pneumatic tire recited in claim 10 is described.

[0042] By providing, at the both sides of the tire equatorial plane of the tread, the circumferential grooves extending in the tire circumferential direction, which circumferential grooves are disposed in the areas of 40 to 60 % of a tread half width from the tire equatorial plane toward the respective tread contact-area ends, water drainage is improved and wet road hydroplaning performance is further improved.

[0043] It should be noted that, if the circumferential grooves are disposed outside the above area and near the tire equatorial plane, rigidity around the tread center becomes in sufficient, and this results in lower control stability.

[0044] On the other hand, if the circumferential grooves are disposed outside the above area and near the respective tread contact-area ends, rigidity of the

blocks at outer sides from the circumferential grooves is reduced, and this results in lower control stability and higher uneven wear.

[0045] It should be noted that, in the pneumatic tire recited in claim 10, although the tread includes the circumferential grooves, lowering of the rain groove wandering resistance is of a degree that does not matter practically, since the number of the circumferential grooves is small (two).

The invention recited in claim 11 is the pneumatic tire recited in any one of claims 1 to 10, wherein the recessed portions at the right and left sides of the tire equatorial plane are arranged not to overlap with each other in the tire width direction.

Next, effect of the pneumatic tire recited in claim 11 is described.

By arranging the recessed portions at the right and left sides of the tire equatorial plane not to overlap with each other in the tire width direction, no area is produced where the recessed portions at one side of the tire equatorial plane and those at the other side of the tire equatorial plane are positioned side by side in the axial direction, so that no insufficiency of contact patch area is brought about.

Effects of the Invention

[0046] As described above, the pneumatic tire recited in claim 1 having the above described structure has an excellent effect that rain groove wandering resistance performance can be improved without sacrificing wet road performance and control stability.

[0047] The pneumatic tire recited in claim 2 having the above described structure has an excellent effect that the recessed portions can work to

efficiently drain water from the tread surface into the steep-angle grooves, and therefore high wet road performance can be obtained.

[0048] The pneumatic tire recited in claim 3 having the above described structure has an excellent effect that high control stability can be obtained. The pneumatic tire recited in claim 4 having the above described structure has an excellent effect that high control stability can be obtained.

[0049] The pneumatic tire recited in claim 5 having the above described structure has an excellent effect that water in the vicinity of the tire equatorial plane in the contact patch area can be efficiently drained, and therefore high wet road performance can be obtained.

[0050] The pneumatic tire recited in claim 6 having the above described structure has an excellent effect that high wet road performance can be obtained while ensuring rigidity of the land portions.

[0051] The pneumatic tire recited in claim 7 having the above described structure has an excellent effect that pattern noise can be suppressed, and land portion rigidity uniform along the circumference and water drainage ability can be obtained.

[0052] The pneumatic tire recited in claim 8 having the above described structure has an excellent effect that high water drainage ability of the tire on a wet road can be obtained.

[0053] The pneumatic tire recited in claim 9 having the above described structure has an excellent effect that water led into the steep-angle grooves can be efficiently drained to the tire axial direction outer sides of the contact area through the transverse grooves, and therefore, high wet road performance can be obtained.

[0054] The pneumatic tire recited in claim 10 having the above described structure has an excellent effect that water drainage ability of the tire on a wet road can further be improved without occurrence of rain groove wandering.

Moreover, the pneumatic tire recited in claim 11 having the above described structure has an excellent effect that no insufficiency of contact patch area is brought about.

Brief Description of Drawings

[0055]

Fig. 1 is a plan view of a tread of a pneumatic tire according to one embodiment of the present invention;

Fig. 2 (A) is a sectional view taken along line 2 (A)-2 (A) in Fig. 1, Fig. 2 (B) is a sectional view taken along line 2 (B)-2 (B) in Fig. 1, and Fig. 2 (C) is a sectional view taken along line 2 (C)-2 (C) in Fig. 1;

Fig. 3 is a plan view of a tread of a pneumatic tire according to prior art example 1;

Fig. 4 is a plan view of a tread of a pneumatic tire according to prior art example 2; and

Fig. 5 is a sectional view taken along line 5-5 in Fig. 4.

Best Mode for Carrying Out the Invention

[0056] Hereinafter, an example of the embodiment of the present invention will be described in detail with reference to the drawings.

[0057] As shown in Fig. 1, a tread 12 of a pneumatic tire 10 includes circumferential grooves 14 formed at opposite sides of a tire equatorial plane

CL, and each circumferential groove 14 extends in a straight line along the tire circumferential direction.

[0058] It should be noted that each circumferential groove 14 is preferably provided within an area of 40 to 60 % of a tread half width (1/2 TW) from the tire equatorial plane CL toward a tread contact-area end 12E.

[0059] Here, the tread width TW refers to a dimension measured along tire width direction from the tread contact-area end 12E at one side in the tire width direction to the tread contact-area end 12E at another side in the tire width direction.

[0060] The tread contact-area ends 12E refers to the outermost ends of the tread contact-area in the tire width direction when a pneumatic tire is mounted on a standard rim defined in JATMA YEAR BOOK (2003 Edition, The Japan Automobile Tyre Manufacturers Association standard), is filled with air to an inner pressure of 100 % of a pneumatic pressure (the maximum pneumatic pressure) corresponding to the maximum load capacity (the load shown in a bold text in the table of correspondence between inner pressures and loads) in the applicable size/ply rating described in JATMA YEAR BOOK, and is loaded to the maximum load capacity.

[0061] It should be noted that, in cases where other standards such as the TRA standard and the ETRTO standard are applied according to places where the tire is used or manufactured, the rim, the pneumatic pressure and the load according to each standard are used.

[0062] Steep-angle grooves 16 are formed at intervals along the tire circumferential direction at the both sides of the tire equatorial plane CL. The steep-angle groove 16 is

inclined with respect to the tire circumferential direction such that, when the pneumatic tire 10 rotates in the direction of arrow A, the

CLAIMS:

1. (Amended) A pneumatic tire comprising:

a land portion disposed on an equatorial plane of a tread, the land portion extending continuously in a tire circumferential direction;

steep-angle grooves provided at opposite sides of a tire equatorial plane of a tread, the steep-angle grooves being inclined at an angle of not more than 45 degrees relative to a tire circumferential direction such that the steep-angle grooves contact the ground from a side thereof near the tire equatorial plane, an end portion of each steep-angle groove near the tire equatorial plane terminating within the land portion; and

recessed portions formed in the land portion along adjacent tread surface side edges at a tire axial direction inner side of the steep-angle grooves, a depth of the recessed portions gradually increasing and a width of the recessed portions gradually decreasing from longitudinal directional middle portions of the steep-angle grooves toward end portions of the steep-angle grooves near the tire equatorial plane.

2. The pneumatic tire as claimed in claim 1, wherein

an angle, relative to the tire circumferential direction, of boundary lines between the recessed portions and a tread surface of the land portion near the tire equatorial plane is set to not more than 15 degrees when viewed in a plan view of the tread, and

an angle of land side wall surfaces of the recessed portions relative to lines normal to the tread surface of the tread is set to not more than 30 degrees

when viewed in cross section along a tire radial direction that is orthogonal to the longitudinal direction of the steep-angle grooves.

3. (Amended) The pneumatic tire as claimed in claim 1or 2, wherein the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at another side of the tire equatorial plane are aligned in a straight line in the circumferential direction.

4. (Amended) The pneumatic tire as claimed in claim 1or 2, wherein the boundary lines, near the tire equatorial plane, between the recessed portions and the tread surface of the land portion are arranged such that the boundary lines of the recessed portions at one side of the tire equatorial plane and the boundary lines of the recessed portions at the other side of the tire equatorial plane are spaced apart from each other outward in the tire axial direction.

5. (Amended) The pneumatic tire as claimed in any one of claims 1 to 4, wherein the recessed portions are formed to extend from longitudinal directional middle portions of the steep-angle grooves to end portions of the steep-angle grooves near the tire equatorial plane, and a length of the recessed portions measured along the tire circumferential direction is set within a range from 25 to 50 % of an arrangement pitch of the steep-angle grooves in the tire circumferential direction.

6. (Amended) The pneumatic tire as claimed in any one of claims 1 to 5, wherein a height of the deepest portion of each recessed portion measured from a groove bottom of the adjacent steep-angle groove to the tire radial direction outer side is set within a range from 25 to 75 % of a groove depth of the steep-angle grooves.

7. (Amended) The pneumatic tire as claimed in any one of claims 1 to 6, wherein the steep-angle grooves are arranged with a phase difference in the circumferential direction between those at one side of the tire equatorial plane and those at the other side of the tire equatorial plane.

8. (Amended) The pneumatic tire as claimed in any one of claims 1 to 7, wherein an angle of the steep-angle grooves relative to the tire circumferential direction is set within a range from 5 to 30 degrees.

9. (Amended) The pneumatic tire as claimed in any one of claims 1 to 8, further comprising transverse grooves provided at the axial direction outer sides from the steep-angle grooves, the transverse grooves opening toward respective tread contact-area ends.

10. (Added) The pneumatic tire as claimed in any one of claims 1 to 9, further comprising circumferential grooves extending in the tire circumferential direction, the circumferential grooves being disposed in areas of 40 to 60 % of a tread half width from the tire equatorial plane toward the respective tread contact-area ends.

11. (Added) The pneumatic tire as claimed in any one of claims 1 to 10, wherein the recessed portions at the right and left sides of the tire equatorial plane are arranged not to overlap with each other in the tire width direction.